AGING CHARACTERISTICS OF POLYAMIDE FIBROUS MATERIALS USED IN PERSONNEL DECELERATORS

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Wright Air Development Division
Wright-Patterson Air Force Base, Ohio

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WADD TECHNICAL NOTE 61-2

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Project 7320

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Wright Air Development Division
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

FOREWORD

This report was prepared by the Fibrous Materials Branch and was initiated under Project No. 7320 "Fibrous Materials for Decelerators and Structures", Task No. 73201 "Organic and Inorganic Fibers". This work was administered under the direction of the Nonmetallic Materials Laboratory, Materials Central, Directorate of Advanced Systems Technology, Wright Air Development Division with Joyce C. McGrath acting as project engineer.

This report covers work from January 1957 to February 1961.

ABSTRACT

The service life of decelerators depends upon the strength retention (over a period of years) of the fibrous materials used in the assembly. If one item has degraded to a point where it is no longer capable of supporting its share of the total load, the whole assembly is subject to failure. At the present time the only reliable method of determining the strength properties of materials suspected of being degraded, either by chemicals, ultra-violet radiation or age, is physical property evaluation. This in the case of a decelerator, means partial or complete destruction of the canopy assembly.

Due to the large quantity of decelerators involved and the fact that it is life saving equipment, it is necessary that information concerning their service life be known at all times. This is accomplished by a sampling procedure of the decelerators which have been in storage.

Results of an evaluation of decelerator assemblies manufactured from 1953 to 1955 has shown that there is a general tendency toward loss in strength particularly in tearing strength. However, with few exceptions, all physical properties for both cloth and cord from the sampled decelerators (five to six and one half years old), still meet the minimum requirements of applicable specifications.

A sampling program extending over a period of years will give a fairly accurate prediction of life expectancy and until such a time as a reliable non-destructive evaluation technique is developed, will remain the best criteria for determining degradation from age.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

R. T. SCHWARTZ, Chief
Nonmetallic Materials Laboratory
Materials Central

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I. INTRODUCTION

The designation of service life, i.e., the length of serviceability in number of years, for personnel and other type decelerators is of continuing interest, particularly the personnel type used by the Air Force. The service life of Air Force personnel decelerators is now seven and one half (7-1/2) years and for the Department of the Army ten (10) years or one hundred (100) uses. The decelerator used by Department of the Army normally accumulate the one hundred uses before the end of the ten (10) year period while the Air Force type might well go the full seven and one half years and only be opened for inspection and repack.

To determine if decelerators will still be completely reliable for use after a number of years in storage, it is necessary to use sampling procedures. To accomplish this a number of decelerators are pulled from stock and sampled so that at least three gores and enough suspension lines for physical evaluation are taken from each decelerator. The serviceability of a particular lot of decelerators will depend on the results of the evaluation of the sampled decelerators.

II. EVALUATION PROGRAM

A service life evaluation program was inaugurated in January 1957 to determine the breakdown if any, of the fibrous materials used in decelerator assemblies. Ten (10) Type T-10 personnel decelerators, stored under normal warehouse storage conditions, were obtained from the Richmond Quartermaster Depot, Richmond, Virginia for the evaluation. The decelerators had the oldest manufacturing dates (2-4 years old) available for decelerators which had never been used. Each year, for a period of four years, five decelerators were taken at random from the ten and samples of cloth and suspension lines removed for physical property evaluation. The decelerators were identified as:

(1) DA 55-5524, Sigmund Eisner Company, Manufacturing Date January 1955

(2) DA 55-196, " " " " September 1954

(3) DA 53-86778, Reliance Manufacturing Company, " " June 1954

(4) DA 55-5267, Sigmund Eisner Company, " " January 1955

(5) DA 53-79801, Reliance Manufacturing Company, " " April 1954

(6) DA 55-5190, Sigmund Eisner Company, " " January 1955

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(7) DA 55-8054, Sigmund Eisner Company, Manufacturing Date April 1955

(8) DA 55-5302, " " " " January 1955

(9) DA 55-5181, Switlik Parachute Company, " " January 1955

(10) DA 55-5220, Sigmund Eisner Company, " " January 1955

Physical properties for the first evaluation were determined by the Better Fabrics Testing Bureau and results reported in WCRT 56-79 dated January 1957. Five of the ten were sampled so that cloth from three separate areas and suspension line from the assembly could be evaluated.

The second evaluation was also accomplished by Better Fabrics Testing Bureau and was reported in April 1958 in WCLT T58-26. Three samples of cloth and one of suspension line from five of the ten assemblies were checked.

The United States Testing Company conducted the third evaluation and results were reported in WCLT R59-102 in October 1959. Five samples of cloth and one of suspension line from five of the ten assemblies were evaluated.

The fourth evaluation was accomplished by the Textile Testing Institute of Swirles Laboratory. Five samples of cloth and one of suspension line from each of the ten decelerators were evaluated. Data are presented in Appendix I, Table 2.

Decelerator, Serial No. DA 53-86778 was the only one sampled each year of the four year period. A comparison of the results is shown in Table 4, 5, and 6. Serial No. DA 53-196 was evaluated the first and fourth year. Results are shown in Tables 7, 8 and 9.

All physical properties for the canopy cloth and suspension lines were determined in accordance with revisions of Specification MIL-C-7020, Cloth, Nylon, Parachute and MIL-C-5040 Cord, Nylon, applicable at the time the assemblies were manufactured.

III. DISCUSSION OF RESULTS

The results of physical property testing over a four year span indicate that there is a general trend toward an overall breakdown. Of the fifteen individual samples of cloth and five of cord tested in 1957 by the Better Fabrics Testing Bureau only one test failed to meet the applicable specification requirement. The percent thickness increase after performance of finish of one sample was over the minimum allowed. (Ref. 1).

In 1958, of the fifteen individual samples submitted, five samples of cloth failed to meet the air permeability requirement of MIL-C-7020, Type I and of five samples of cord, two failed to meet the picks per inch requirement of MIL-C-5040, Type II. Physical property evaluation was again conducted by Better Fabrics Testing Bureau (Ref. 2).

The United States Testing Company conducted the third series of tests in 1959. Twenty-five individual samples of cloth and five of cord were tested. Only one sample of cloth met all of the requirements of MIL-C-7020. The other twenty-four samples failed to meet either the breaking strength, air permeability or permanence of finish requirement. Of these thirty-two percent of the samples did not meet the breaking strength requirement, forty percent the air permeability and eight percent the permanence of finish requirement. (Ref. 3).

The fourth series was conducted by the Textile Testing Institute, Division of Swirles and Company of Los Angeles, California. Five individual samples of cloth and one of cord from each of the ten decelerators were evaluated. From the fifty individual test samples, fourteen percent failed to meet the warp elongation requirement, twenty-eight percent the air permeability requirement of MIL-C-7020, Type I. In the permanence of finish test, thirty percent failed to meet the warp shrinkage, sixty-eight percent the filling shrinkage, ten percent the percent thickness change and eighteen percent the percent air permeability change specified in MIL-C-7020. Of the ten individual samples of cord tested, one failed to meet the weight requirement of Specification MIL-C-5040, Type II. There were also minor variations in turns per inch of twist for the final ply of the sleeve and core yarns.

Part of the descrepancies throughout the program might possibly be attributed to the fact that the evaluations were performed by personnel from three separate organizations. However, this would be a minor factor if the evaluation is conducted in accordance with applicable specifications and Federal Specification, General test methods, CCC-T-191b. The breaking strength and tearing strength (See Table 5 and 7) show a gradual breakdown from year to year. Although there were no tearing strength failures, the tear strength did decrease each year. This would appear to indicate that the finishing oils leach out over a period of years causing the individual yarns to break instead of sliding or bunching together. This leaching out of the finishing oils might also account for the high percentage of failures in permanence of finish for the last two testing periods.

IV. CONCLUSIONS

At the date of the last (of four) evaluations, all decelerators were from six (6) to six and one half (6-1/2) years old, with Serial No. DA 53-86778 manufactured in June 1954 by Reliance Manufacturing Company being the oldest.

The trend in breakdown, in both the canopy and suspension line materials from the decelerators indicate that there is a year by year progression in breakdown, of the physical properties of the materials.

In view of the results obtained during the four year evaluation program, it is concluded that the present seven and one half (7-1/2) service life of Air Force personnel decelerators should be reduced.

TABLE I

LIST OF SAMPLES EVALUATED IN 1960

Decelerator Data	Fabric Sample Code	Card Sample Code
S/N DA 55-5224	F-1, Panel 27	C-1
Sigmund Eisner and Company	F-2, " 7	
Mfg. Date - January 1955	F-3, " 12	
	F-4, " 17	
	F-5, " 22	
S/N DA 55-196	F-6, " 14	C-2
Sigmund Eisner and Company	F-7, " 9	
Mfg. Date - September 1954	F-8, " 4	
	F-9, " 29	
	F-10, " 24	
S/N DA 53-86778	F-11, " 17	C-3
Reliance Manufacturing Company	F-12, " 22	
Mfg. Date - June 1954	F-13, " 27	
	F-14, " 2	
	F-15, " 7	
S/N DA 55-5267	F-16, " 27	C-4
Sigmund Eisner and Company	F-17, " 2	
Mfg. Date - January 1955	F-18, " 7	
	F-19, " 12	
	F-20, " 17	
S/N DA 53-79891	F-21, " 8	C-5
Reliance Manufacturing Company	F-22, " 13	
Mfg. Date - April 1954	F-23, " 18	
	F-24, " 23	
	F-25, " 28	
S/N DA 55-5190	F-26, " 13	C-6
Sigmund Eisner and Company	F-27, " 18	
Mfg. Date - January 1955	F-28, " 23	
	F-29, " 28	
	F-30, " 3	
S/N DA 55-8054	F-31, " 22	C-7
Sigmund Eisner and Company	F-32, " 27	
Mfg. Date - April 1955	F-33, " 2	
	F-34, " 7	
	F-35, " 12	
S/N DA 55-5908	F-36, " 3	C-8
Sigmund Eisner and Company	F-37, " 8	
Mfg. Date - January 1955	F-38, " 13	
	F-39, " 18	
	F-40, " 23	

TABLE I

LIST OF SAMPLES EVALUATED IN 1960 (CONT'D)

Decelerator Data	Fabric Sample Code	Cord Sample Code
S/N DA 55-5181	F-41, Panel 2	C-9
Switlik Parachute Company	F-42, " 7	
Mfg. Date - January 1955	F-43, " 12	
	F-44, " 17	
	F-45, " 22	
S/N DA 55-5220	F-46, " 27	C-10
Sigmund Eisner and Company	F-47, " 2	
Mfg. Date - January 1955	F-48, " 7	
	F-49, " 12	
	F-50, " 17	

[illegible] CCFA

TABLE 2

[illegible] - [illegible] - MIL-C-7020, TYPE I

Sample No.		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Weight (oz/yd^2)		1.01	1.01	1.0	1.02	1.03	1.01	1.03	1.02	1.02	1.03
Thickness (in)		.0031	.0031	.0032	.0032	.0031	.0031	.0030	.0029	.0030	.0029
Acidity, pH		7.3	7.3	7.3	7.3	7.2	7.1	7.1	7.2	6.9	7.3
Nonfibrous Materials (%)		1.0	1.6	1.7	1.5	1.1	0.8	0.7	0.8	0.5	0.5
Breaking Strength (lbs/in)	W	41.0	40.0	40.0	40.0	42.0	42.0	41.0	41.0	41.0	41.0
	F	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.0	40.0
Elongation (%)	W	22.0	25.0	20.0*	23.0	20.0*	22.0	24.0	23.0	21.0*	23.0
	F	28.0	30.0	32.0	29.0	28.0	36.0	33.0	34.0	27.0	31.0
Tearing Strength (lbs)	W	6.3	6.0	6.3	5.8	6.3	5.0	4.9	4.6	5.3	5.3
	F	4.6	5.8	5.2	5.6	6.3	5.0	4.8	4.5	5.0	5.1
Air Permeability ($ft^3/min/ft^2$)		118.0	116.2	81.6	106.4	96.4	102.6	107.5	103.8	100.8	98.8
Permanence of Finish											
Shrinkage (%)	W	1.72	1.89	1.11	1.22	1.39	1.50	1.44	1.44	1.44	1.94
	F	1.89*	2.11*	1.39*	1.28*	1.67*	1.44*	0.50*	1.56*	1.39*	1.44*
Thickness Change (%)		12.9*	12.9*	3.1	N/C	3.2	3.[illegible]	3.3	3.4	N/C	3.4
Permeability Change (%)		-1.96	-9.7	-0.56	-1.34	3.35	-7.35	-5.07	-2.95	-3.62	0.39

TABLE 2

TEST RESULTS - NYLON CLOTH, MIL-C-7020, TYPE I (CONT'D)

Sample No.		Z11	Z12	Z13	Z14	Z15	Z16	Z17	Z18	Z19	Z20
Weight (oz/yd^2)		1.02	1.01	1.02	1.01	1.03	1.03	1.02	1.02	1.01	1.03
Thickness (in)		.0028	.0029	.0030	.0028	.0029	.0029	.0031	.0031	.0031	.0025
Acidity, pH		7.2	7.1	6.6	7.2	6.7	6.9	7.6	7.4	7.9	6.9
Nonfibrous Materials (%)		0.2	0.1	0.4	1.3	0.3	2.0	1.4	0.5	1.0	0.9
Breaking Strength (lbs/in)	W	42.0	42.0	42.0	41.0	42.0	42.0	41.0	43.0	42.0	42.0
	F	40.0	43.0	41.0	41.0	41.0	40.0	42.0	42.0	42.0	40.0
Elongation (%)	W	22.0	27.0	23.0	23.0	22.0	26.0	22.0	23.0	23.0	25.0
	F	33.0	30.0	26.0	31.0	30.0	32.0	33.0	33.0	33.0	27.0
Tearing Strength (lbs)	W	5.4	5.3	5.5	5.6	5.3	5.3	5.5	5.4	5.4	5.8
	F	5.2	5.5	5.1	5.4	5.1	5.4	5.4	5.5	5.5	5.6
Air Permeability ($ft^3/min/ft^2$)		86.0	82.6	108.3	109.2	107.3	85.5	95.2	96.6	98.6	59.0*
Permanence of Finish											
Shrinkage (%)	W	0.94	0.83	1.11	1.17	1.09	1.50	1.28	0.94	1.44	2.56*
	F	0.39	0.17	0.50	0.50	0.94	1.17*	0.67	0.83	0.33	1.67*
Thickness Change (%)		7.1	3.4	NC	10.7	3.4	NC	3.2	6.4	9.7	20.0*
Permeability Change (%)		3.94	9.88	-25.01*	-44.85	-0.56	-4.81	9.4	25.89*	9.47	-3.49

[redacted]

Sample No.		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Weight (oz/yd^2)		1.08	1.02	1.09	1.01	1.09	1.02	1.0	1.05	1.02	1.07
Thickness (in)		.0029	.0030	.0031	.0031	.0030	.0030	.0031	.0030	.0030	.0030
Acidity, p^H		6.9	7.1	6.6	6.4	6.6	7.3	6.9	6.8	6.7	6.9
Nonfibrous Materials (%)		0.4	0.9	1.0	0.8	0.8	0.2	0.9	0.9	1.3	0.7
Breaking Strength (lbs/in)	W	42.0	42.0	40.0	42.0	41.0	41.0	42.0	42.0	42.0	42.0
	F	42.0	40.0	40.0	40.0	40.0	42.0	43.0	45.0	45.0	44.0
Elongation (%)	W	23.0	29.0	26.0	25.0	25.0	20.0*	27.0	25.0	25.0	24.0
	F	31.0	33.0	34.0	31.0	27.0	24.0	31.0	31.0	30.0	30.0
Tearing Strength (lbs)	W	5.4	5.7	5.7	5.5	5.7	5.3	5.5	5.5	5.5	5.5
	F	5.3	5.5	5.4	5.3	5.2	5.3	5.2	5.3	5.6	5.3
Air Permeability ($ft^3/min/ft^2$)		102.0	114.1	82.6	116.6	102.2	57.9*	53.9*	74.5*	70.7*	72.7*
Permanence of Finish											
Shrinkage (%)	W	1.72	2.17	1.44	1.94	1.22	2.11	1.44	1.39	1.33	1.11
	F	1.17*	1.67*	1.06*	0.61	0.89	1.61*	0.89	0.44	0150	1.06*
Thickness Change (%)		10.3	10.0	EC	3.2	3.3	3.3	6.4	6.6	6.6	6.6
Permeability Change (%)		-1.05	-5.69	5.96	-10.37	0.09	8.33	12.6	-20.4	-4.66	-8.92

TABLE 2

TEST RESULTS - MUSLIN CLOTH, MIL-C-7020, TYPE I (CONT'D)

Sample No.		F31	F32	F33	F34	F35	F36	F37	F38	F39	F40
Weight (oz/yd^2)		1.02	1.03	1.01	1.03	1.02	1.02	1.03	1.01	1.02	1.03
Thickness (in)		.0030	.0029	.0030	.0030	.0030	.0026	.0027	.0027	.0026	.0027
Acidity, p^H		6.9	7.2	7.0	7.0	6.7	6.7	6.6	6.8	6.4	6.4
Nonfibrous Materials (%)		0.4	0.7	0.4	0.4	0.2	1.6	1.1	1.0	0.9	1.3
Breaking Strength (lbs/in)	W	44.0	40.0	44.0	43.0	43.0	43.0	43.0	43.0	44.0	43.0
	F	40.0	44.0	40.0	40.0	40.0	40.0	40.0	41.0	40.0	41.0
Elongation (%)	W	23.0	21.0*	25.0	23.0	25.0	23.0	26.0	25.0	24.0	24.0
	F	33.0	25.0	33.0	30.0	34.0	26.0	28.0	26.0	34.0	30.0
Tearing Strength (lbs)	W	5.7	5.5	5.7	5.7	5.6	5.8	5.7	5.4	5.7	5.4
	F	5.4	5.4	5.4	5.5	5.3	5.3	5.5	5.4	5.1	5.5
Air Permeability ($ft^3/Min/ft^2$)		124.5*	100.0	118.2	129.3*	124.8*	55.1*	65.7*	75.6*	58.2*	58.7*
Permanence of Finish											
Shrinkage (%)	W	2.00	2.50*	2.28*	2.17*	2.11*	2.06*	2.33*	2.06*	2.39*	2.17*
	F	1.11*	1.72*	1.22*	0.83	0.72	1.83*	1.56*	1.50*	1.67*	1.78*
Thickness Change (%)		6.6	10.3*	6.6	6.6	NC	3.6	3.7	NC	15.4*	7.4
Permeability Change (%)		-14.17	-28.9*	4.93	-1.52	12.48	19.25*	-5.96	-18.54*	-24.96*	-19.48*

TABLE 2

TEST RESULTS-NYLON CLOTH, MIL-C-7020, TYPE I (CONT'D)

Sample No.		F41	F42	F43	F44	F45	F46	F47	F48	F49	F50
Weight (oz/yd^2)		1.03	1.03	1.03	1.02	1.02	1.02	1.03	1.03	1.03	1.03
Thickness (in)		.0029	.0030	.0031	.0030	.0030	.0031	.0030	.0030	.0030	.0030
Acidity, pH		7.3	5.7	5.8	7.2	7.4	7.2	6.8	7.1	7.0	7.2
Nonfibrous Materials (%)		1.2	1.1	0.4	1.1	1.2	1.7	1.0	0.9	0.7	1.1
Breaking Strength (lbs/in)	W	44.0	44.0	44.0	45.0	44.0	43.0	43.0	42.0	42.0	43.0
	F	41.0	42.0	40.0	42.0	40.0	41.0	40.0	41.0	41.0	41.0
Elongation (%)	W	25.0	23.0	24.0	23.0	21.0*	25.0	24.0	25.0	20.0*	25.0
	F	30.0	28.0	25.0	32.0	33.0	33.0	32.0	31.0	30.0	29.0
Tearing Strength (lbs)	W	5.3	5.5	5.5	5.7	5.4	5.3	5.5	5.7	5.7	5.4
	F	5.3	5.3	5.3	5.4	5.2	5.3	5.6	5.3	5.5	5.5
Air Permeability ($ft^3/Min/ft^2$)		90.8	89.2	105.4	95.3	99.9	95.8	115.0	101.9	95.7	115.2
Permanence of Finish											
Shrinkage (%)	W	2.28*	1.94	2.0	1.44	2.22*	1.44	1.94	2.06*	2.11*	2.11*
	F	1.56*	1.39*	1.33*	1.94*	1.39*	1.44*	1.11*	1.06*	1.17*	0.94
Thickness Change (%)		3.4	3.3	NC	6.6	NC	6.6	6.6	6.6	3.3	6.6
Permeability Change (%)		-11.38	-8.18	-11.99	-1.77	-11.14	-1.6	-3.98	-9.03	-1.71	-8.11

* Does not meet specification requirement (requirement in effect when fabric was procured).

TABLE 3

TEST RESULTS, NYLON CORD, MIL-C-5040, TYPE II

Sample No.	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10
Breaking Strength (lbs)	425.9	442.2	444.8	433.2	434.4	434.7	417.1	431.9	420.3	399.8
Elongation (%)	51.2	58.0	56.4	60.2	51.2	53.6	48.8	57.2	55.0	54.6
Weight (yds/lb)	106.6	106.4	106.2	106.6	107.2	106.2	105.4	106.6	105.8	105.4
Colorfastness to										
Laundry	All samples were excellent									
Dry Cleaning	All samples were excellent									
Light, 40 hrs.	All samples were excellent									
Core Construction										
Number of Yarns	4	4	4	4	4	4	4	4	4	4
Final Ply	3	3	3	3	3	3	3	3	3	3
Sleeve Construction										
Number of Carriers	32	32	32	32	32	32	32	32	32	32
Ends per Carrier	1	1	1	1	1	1	1	1	1	1
Final Ply	3	3	3	3	3	3	3	3	3	3
Twist (turns per inch)										
Core Yarns										
Initial Ply	11.8	10.5	13.8	10.5	12.0	10.7	13.5	11.7	10.7	11.0
Final Ply	5.1*	6.8	7.2	6.1	8.1	6.1	7.2	5.5*	6.2	5.6
Sleeve Yarns										
Singles	6.1	5.7	5.3	5.7	6.8	5.7	6.7	6.2	5.8	5.8
Final Ply	8.0	8.0	9.0	8.8	9.0	8.0	10.0	8.0	8.0	8.0

TABLE A

LIST OF PANELS AND CORES SAMPLED FROM DESICCATOR S/N 51-86778

Fabric Sample Tested	Code No. Assigned
1957, F-7, Panel 4	1A
F-8, Panel 14	2A
F-9, Panel 24	3A
1958, F-7, Panel 5	1B
F-8, Panel 15	2B
F-9, Panel 25	3B
1959, F-11, Panel 6	1C
F-12, Panel 11	2C
F-13, Panel 16	3C
F-14, Panel 21	4C
F-15, Panel 26	5C
1960, F-11, Panel 17	1D
F-12, Panel 22	2D
F-13, Panel 27	3D
F-14, Panel 2	4D
F-15, Panel 7	5D
Core Samples Tested	
1957	A
1958	B
1959	C
1960	D

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TABLE 5

TEST RESULTS-NYLON CLOTH (MIL-C-7020,TYPE I) FROM DECELERATOR S/N 53-06778-29

Sample No.		1a	2a	3a	1B	2B	3B	1C	2C	3C	4C
Weight (oz/yd^2)		1.02	1.07	1.05	1.09	1.06	1.06	1.1	1.1	1.1	1.1
Thickness (in)		.0025	.0025	.0024	.0026	.0022	.0025	.0032	.0032	.0032	.0030
Acidity, pH		7.1	7.1	6.8	6.3	6.4	6.8	6.9	7.0	7.0	7.0
Nonfibrous Materials (%)		0.77	1.07	0.80	0.57	0.62	0.26	0.5	0.4	0.2	0.4
Breaking Strength (lbs/in)	W	44.2	44.0	44.6	47.8	44.0	43.2	43.0	42.8	45.6	41.6
	F	45.2	42.8	43.4	43.2	43.2	42.-	45.2	41.6	40.8	39.0*
Elongation (%)	W	25.0	24.0	25.0	32.7	33.3	33.3	29.8	27.4	24.4	28.8
	F	28.0	30.0	30.0	43.4	38.0	36.8	37.8	32.8	35.0	32.0
Tearing Strength (lbs)	W	7.8	6.6	6.6	5.0	4.6	5.4	6.7	6.6	6.1	7.1
	F	6.2	6.2	6.2	6.4	5.6	4.6	7.9	7.9	7.2	7.4
Air Permeability ($ft^3/min/ft^2$)		109.0	101.0	107.2	102.8	99.4	125.4*	116.6	138.6*	119.6	114.4
Permanence of Finish											
Shrinkage (%)	W	1.0	1.0	1.0	1.0	1.0	1.5	1.7	1.7	1.4	1.4
	F	1.0	0.5	NC	1.0	1.0	1.0	0.8	0.7	1.3*	0.9
Thickness Change (%)		4.0	4.0	8.34	-11.5	-4.5	-12.0	-6.2	-6.2	-6.2	6.6
Permeability Change (%)		1.28	2.58	1.3	2.7	3.0	-1.9	-6.5	-6.1	-9.0	-7.9

*Does not meet specification requirement (requirement in effect when fabric was procured).

TABLE 5

TEST RESULTS, NYLON CLOTH (MIL-C-7020, TYPE [illegible]) FROM DECELERATOR S/N 53-86778 (CONT'D)

Sample No.		5C	1D	2D	3D	4D	5D
Weight (oz/yd^2)		1.1	1.01	1.01	1.02	1.01	1.03
Thickness (in)		.0030	.0028	.0029	.0030	.0028	.0029
Acidity, pH		7.0	7.2	7.1	6.6	7.2	6.7
Nonfibrous Materials (%)		0.4	0.2	0.1	0.4	1.3	0.3
Breaking Strength (lbs/in)	W	42.6	42.0	42.0	42.0	41.0	42.0
	F	41.2	40.0	43.0	41.0	41.0	41.0
Elongation (%)	W	31.4	22.0	27.0	23.0	23.0	22.0
	F	37.6	33.0	30.0	26.0	31.0	30.0
Tearing Strength (lbs)	W	6.6	5.4	5.3	5.5	5.6	5.3
	F	7.9	5.2	5.5	5.1	5.4	5.1
Air Permeability ($ft^3/Min/ft^2$)		110.4	86.0	82.6	101.3	103.2	107.3
Permanence of Finish							
Shrinkage (%)	W	1.8	0.94	0.83	1.11	1.17	1.89
	F	1.4*	0.39	0.17	0.50	0.50	0.94
Thickness Change (%)		NC	7.1	3.4	NC	10.7	3.4
Permeability Change (%)		3.3	3.94	9.88	-15.01*	-14.85	-0.54

TABLE 6

TEST RESULTS NYLON CORD (MIL-C-5040, TYPE II)
FROM DECELERATOR S/N 53-86776

Sample No.	A	B	C	D
Breaking Strength (lbs)	479.0	432.0	450.0	444.8
Elongation (%)	42.4	44.4	45.0	56.4
Weight (yds/lb)	106.9	134.0	110.7	106.2
Colorfastness to				
Laundry	Good	Good	Good	Excellent
Dry Cleaning	Good	Good	Good	Excellent
Light, 20 hrs. a/	Good	Good	Good	Excellent
Core Construction				
Number of Yarns	4	4	4	4
Final Ply	3	3	3	3
Sleeve Construction				
Number of Carriers	32	32	32	32
Ends per Carrier	1	1	1	1
Picks per Inch	28.0	27.0	26.0	No data
Final Ply	3	3	3	3
Twist (Turns per Inch)				
Core Yarns				
Initial Ply	10.7 S	13.3 S	13.5 S	13.8 S
Final Ply	7.0 Z	7.2 Z	7.0 Z	7.2 Z
Sleeve Yarns				
Singles	5.8Z	5.4 Z	5.0 Z	5.3 Z
Final Ply	9.0 S	8.7 S	8.5 S	9.0 S

a/ Sample D exposed 40 hrs.

TABLE 7

List of Cloth and Cord Samples from Decelerator S/N DA 53-196

Fabric Samples Tested	Code No. Assigned
1957, F-10, Panel 5	1A
F-11, " 15	2A
F-12, " 25	3A
1960, F-6, " 14	1B
F-7, " 9	2B
F-8, " 4	3B
F-9, " 29	4B
F-10, " 24	5B

Cord Samples Tested	
1957, C-4	A
1960, C-2	B

TABLE 8

TEST RESULTS-NYLON CLOTH (MIL-C-7020, TYPE I) FROM DECELERATOR SERIAL NO. DA 53-196

Sample No.		1A	2A	3A	1B	2B	3B	4B	5B
Weight (oz/yd²)		1.03	1.03	1.04	1.01	1.03	1.02	1.02	1.03
Thickness (in)		.0025	.0030	.0026	.0031	.0030	.0029	.0030	.0029
Acidity, pH		6.3	6.8	7.0	7.1	7.1	7.2	6.9	7.3
Nonfibrous Material (%)		0.81	0.78	0.74	0.8	0.7	0.8	0.5	0.5
Breaking Strength (lbs/in)	W	42.4	42.2	43.4	42.0	41.0	41.0	41.0	41.0
	F	44.4	43.4	44.4	40.0	40.0	40.0	41.0	40.0
Elongation (%)	W	28.0	24.0	27.0	22.0	24.0	23.0	21.0*	23.0
	F	29.0	28.0	25.0	36.0	33.0	34.0	27.0	21.0*
Tearing Strength (lbs)	W	6.6	7.4	5.6	5.0	4.9	4.6	5.3	5.3
	F	5.4	6.8	7.2	5.0	4.8	4.5	5.0	5.1
Air Permeability ($ft^3/Min/ft^2$)		102.0	111.8	100.0	102.6	107.5	103.8	100.8	98.8
Permanence of Finish									
Shrinkage (%)	W	1.0	1.0	1.5	1.5	1.44	1.44	1.44	1.94
	F	1.0	1.0	1.0	1.44*	1.50*	1.56*	1.39*	1.44*
Thickness Change (%)		4.0	-16.6*	11.5*	3.2	3.3	3.4	NC	3.4
Permeability Change (%)		0.98	3.76	3.0	-7.35	-5.07	-4.95	-3.62	0.39

* Does not meet specification requirement (requirement in effect when fabric was procured)

TABLE 9

TEST RESULTS - NYLON CORD (MIL-C-5040, TYPE II)
FROM DECELERATOR SERIAL NO. DA 55-196

Sample No.	A	B
Breaking Strength (lbs)	465.0	444.8
Elongation (%)	43.0	56.4
Weight (yds/lb)	106.9	106.2
Colorfastness to		
Laundry	Good	Excellent
Dry Cleaning	Good	Excellent
Light, 80 Hrs [a/]	Good	Excellent
Core Construction		
Number of Yarns	4	4
Final Ply	3	3
Sleeve Construction		
Number of Carriers	32	32
Ends per Carrier	1	1
Picks per Inch	26.4	No data
Final Ply	3	3
Twist (turns per inch)		
Core Yarns		
Initial Ply	10.5 "S"	13.8 "S"
Final Ply	6.1 "S"	7.2 "Z"
Sleeve Yarns		
Singles	6.7 "Z"	5.3 "Z"
Final Ply	8.6 "S"	9.0 "S"

a/ Sample B exposed 40 Hrs.

TABLE 10

Requirements of Specification MIL-C-7020, Type I*

Weight (oz/yd^2)	1.1 Max.
Thickness (in)	.0032 Max.
Acidity p^H	5.0 - 9.0
Non Fibrous Materials (%)	2 (Max)
Breaking Strength (lbs/in)	
Warp	40 (Min)
Filling	40 (Min)
Tearing Strength (lbs)	
Warp	3.5 (Min)
Filling	3.5 (Min)
Elongation (%)	
Warp	22 (Min)
Filling	22 (Min)
Air Permeability ($ft^3/Min/ft^2$)	80-120
Permanence of Finish	
Shrinkage (%)	
Warp	2 (Max)
Filling	1 (Max)*
Thickness Change (%)	10 (Max Increase)
Permeability Change (%)	15 (Max)

* Requirement in effect when parachutes were procured.

TABLE II

Requirements of Specification MIL-C-5040, Type II

Breaking Strength (lbs)	375 (Min)
Elongation (%)	30 (Min)
Weight (yds/lb)	105 (Min)
Colorfastness to Laundering at 110°F	Good
Colorfastness to Dry Cleaning	Good
Colorfastness to Sunlight (20 hrs.)	Good
Core Construction	
Number of Yarns	4-7
Ply	2 0/5/3
Sleeve Construction	
Number of Carriers	32 or 36
Ends per Carrier	1
Picks per inch	26 - 28
Ply	2 0/3
Twist (turns/inch)	
Core Yarn	
Initial Ply	10-14
Final Ply	6-8
Sleeve Yarn	
Ply	5-7
Singles	7-9.5

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